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# THE BASIS OF GRAPE STANDARDIZATION

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With the great expansion, both recent and prospective, in the volume of the crop of shipping grapes in California, the importance and necessity of proper standardization becomes increasingly evident. There is, however, much difference of opinion among growers and shippers as to what constitutes proper standardization. Any evidence, therefore, which may throw light on this question should be helpful in arriving at a satisfactory solution.

During the shipping season of 1918, the Division of Viticulture and Fruit Products of the College of Agriculture collected data with the object of supplying the needed evidence. The data obtained were not sufficiently extensive to settle the question but they have some value, especially in the light of the experience of the intervening seasons, and it seems advisable to publish them as a contribution to our knowledge of the facts and as a basis for future investigation.

## THE OBJECT OF STANDARDIZATION

The object of the establishment of a legal standard of saleability for grapes has to do with the protection of both the grower and the consumer. If the consumer is not satisfied, the grower must eventually go out of business. If the grower does not realize a satisfactory return, the consumer will soon be unable to obtain grapes. The interests of the two are therefore interdependent.

Whichever viewpoint is taken, therefore, if the subject is considered in all its parts, the conclusion must be the same. This conclusion will be a compromise between two impossible extremes—between the high price desired by the grower for all of his grapes and the high quality at a low price desired by the consumer.

The standard deals directly, of course, only with the quality, but its value to the grower consists in its effect on the price and on the quantity of grapes sold. If it is set too high, grapes will be excluded from the market for which the consumer would be willing to pay prices profitable to the grower. If it is set too low, grapes that disgust the purchaser may be sold at a profitable price, in small quantities and for a short time. At either extreme, the market is limited and the value of the industry considered as a whole and as a permanent resource of the state decreased. If the question is judged by narrow local interests or short-sighted views of immediate profits, the decision will be unwise.

It should be considered rather on the basis of the effects of the standard or standards proposed on an important industry of the state, and with respect to the future in so far as this may be possible.

#### THE NATURE OF STANDARDIZATION

A legal standard of quality is quite different from the standard or ideal which the producer of grapes must keep in mind if he is to obtain the full value of his operations. The ideal is a maximum or optimum standard which the grower can approach though seldom reach. The legal standard, on the other hand, is a minimum standard which the producer must reach under pain of disgusting the buyer of his grapes and suffering from the latter's resentment as shown by a decrease of future purchases.

The quality of a grape includes many factors, which are of two kinds: those which are evident on cursory inspection, and those which are revealed only by careful examination or by consumption. The first might be left to the purchaser, who is not likely to buy grapes which appear unattractive or inedible, if it were not for the various devices of arrangement and packing by which defects can be concealed.

The principal factors are (a) those which appeal to the eye, e.g. color, size, and form; (b) those which appeal to the palate, e.g. sweetness, acidity, flavor and texture; and (c) those which concern the "soundness" or condition of the fruit in regard to mold, decay, fermentation and mechanical injuries.

Most or all of the factors under (a) and (c) can be evaluated by the eye of the trained and experienced inspector. Those (b) which depend on the reactions of the palate, however, offer much difficulty and are among the most important. They are included under the

term maturity or ripeness. When a grape has reached the stage of its development at which it can be eaten with satisfaction, it is said to be *ripe*; when it has reached the stage at which it gives the most satisfaction, it is said to be *perfectly ripe*. When it passes this stage, it gradually deteriorates and becomes *over-ripe*.

It is generally conceded that the legal or minimum standard should be set at the point which corresponds with the first of these stages, i.e the ripe stage.

It is here that the greatest difficulty arises. As in all matters of taste, individuals differ. One may prefer an extremely sweet grape; another a degree of acidity that is disagreeable to the first. The taste of the same individual, moreover, differs with different conditions of health or of appetite. A minimum standard, therefore, must be fixed at a point that will satisfy most of the possible purchasers in their usual or normal condition.

In order to determine this point, there is no certain method but one which will discover the average taste of the consumer. When the proper standard of minimum ripeness is determined in this way, the problem of enforcement and of the detection of failures to reach the standard must be solved. The various and variable tastes of inspectors cannot be relied upon. There is needed therefore some character which can be measured exactly and which is unaffected by the idiosyncrasies and the physiological or psychological condition of the inspector.

Observation has shown that the various factors characteristic of ripeness are closely correlated. As the sweetness increases, so does the flavor and the agreeability of the color and texture, while the acidity decreases. A measure of one, therefore, is to some extent a measure of the others. In fact, sweetness and ripeness are often spoken of as though they were identical. Within certain limits but with important exceptions, this is nearly correct.

Sweetness is a taste and cannot be measured exactly. It is usually assumed that the amount of sugar in the grape is a measure of its sweetness. As the amount of sugar present can be easily and rapidly determined with sufficient accuracy for the purpose, if the assumption were correct, the difficulty would be much decreased. It is not, however, strictly correct.

Sweetness is an effect upon the organs of taste and depends upon the ratio of sugar to acid as well as upon the amount of sugar present.

The ratio of sugar to acid has been proposed as a measure of ripeness. The defect of this measure for grapes is that a grape with

little sugar and little acid may have the same "sugar:acid" ratio as a grape with high sugar and high acid. In the first case, the grape may be undernourished, defective in texture and totally lacking in pleasing flavor and quality, while, in the second case, it may be perfectly ripe and of high quality. With grapes of equal sugar percentages, the sugar:acid ratio might be an excellent measure of relative quality.

### INVESTIGATION OF 1918

With the object of discovering how far the sugar content could be relied upon to determine quality and what advantage there would be in the substitution or addition of the acid test or of the sugar:acid ratio, the data to be considered were collected in 1918.

*The Grape Standardization Law of California.*—In 1915, the legislature of California enacted a law for the standardization of fruit packing, which included grapes for table use. This law was amended and expanded in 1917 and 1919 and again in 1921. The provision of the act of 1921 regarding maturity or sugar content is that all table grapes for shipping must contain at least 17° Balling, except in the case of the varieties Emperor, Cornichon, Gros Colman, Burger, Pierce, and Isabella, which may be shipped at 16° Balling. This includes all grapes shipped except those intended for manufacturing purposes and special grades such as "California Fancy Emperor" packed in sawdust, for which special requirements are made.

*Collection of Data.*—The guiding principle of the investigation was to compare the judgments of the consumers with the readings of the Balling saccharometer and from the data thus obtained to try to discover how far they agreed and whether the 17° Balling or 16° Balling standard was suited to attain the objects of the law or whether it should be changed for all grapes or for grapes of some varieties or for some localities.

The data collected covered 369 samples from 77 packing houses and 7 markets in several localities extending from the Imperial Valley through the San Joaquin and Sacramento valleys to Lodi. The varieties tested were:

	Samples		Samples
Malaga .....	120	Black Prince .....	22
Tokay .....	99	Cornichon .....	13
Sultanina .....	43	Muscat .....	10
Emperor .....	42	Miscellaneous (11 var.) ..	20

The method of collecting the data was to form a tasting jury of any volunteers who could be found in the packing house and then to obtain their judgments on samples of grapes which were in the packing house ready for packing or already packed. From three to six persons, including J. R. Zion, Assistant in Viticulture, who collected the data, constituted the jury. Each member of the jury was instructed to place each sample of grapes in one of the following classes, each of which was given a numerical value.

Class	Value	Class	Value
1. Excellent .....	+ 30	4. Poor .....	0
2. Very good .....	+ 20	5. Bad .....	— 10
3. Good .....	+ 10		

The final classification of the sample was made by adding the numbers assigned by each taster and dividing the sum by the number of tasters. This gave the average judgment of the jury.

The sample was then tested for its Balling degree with an hydrometer and the acidity determined volumetrically as tartaric acid.

The data for all the samples of the principal varieties which had 15.5° Balling or over are shown graphically in figure 1. This chart shows some of the limitations of the method and also the need of more records before final conclusions should be drawn. It shows, however, some interesting facts and tendencies.

*Influence of Locality.*—It has been contended that a standard of sugar suitable for one locality might be unjust to another. There is some apparent justification for this contention in the records for Malaga in the Imperial and in the San Joaquin valleys. Every sample above 17.5° Balling from Imperial was classed as good or better, while nearly 20 per cent of those of the same sugar content from the San Joaquin Valley were classed as bad, and over 30 per cent as poor. It should be noted, however, that all the samples of 17° Balling at Imperial were classed as bad and that over 10 per cent of the same degree of sugar in the San Joaquin Valley were considered good.

One reason for this discrepancy is plain. There were 22 samples of 17° grapes tested from the San Joaquin Valley so that we probably have a fair average there, while from Imperial there were only 2 samples—much too few for a reliable judgment. This explanation is less plausible for the discrepancy between the 5 Imperial samples showing 19° Balling, which are all “good,” and the 4 San Joaquin samples of the same Balling degree which are 50 per cent poor. The cause in this case may be the more lenient judgment of the first grapes of the season before the palate becomes jaded or too critical.

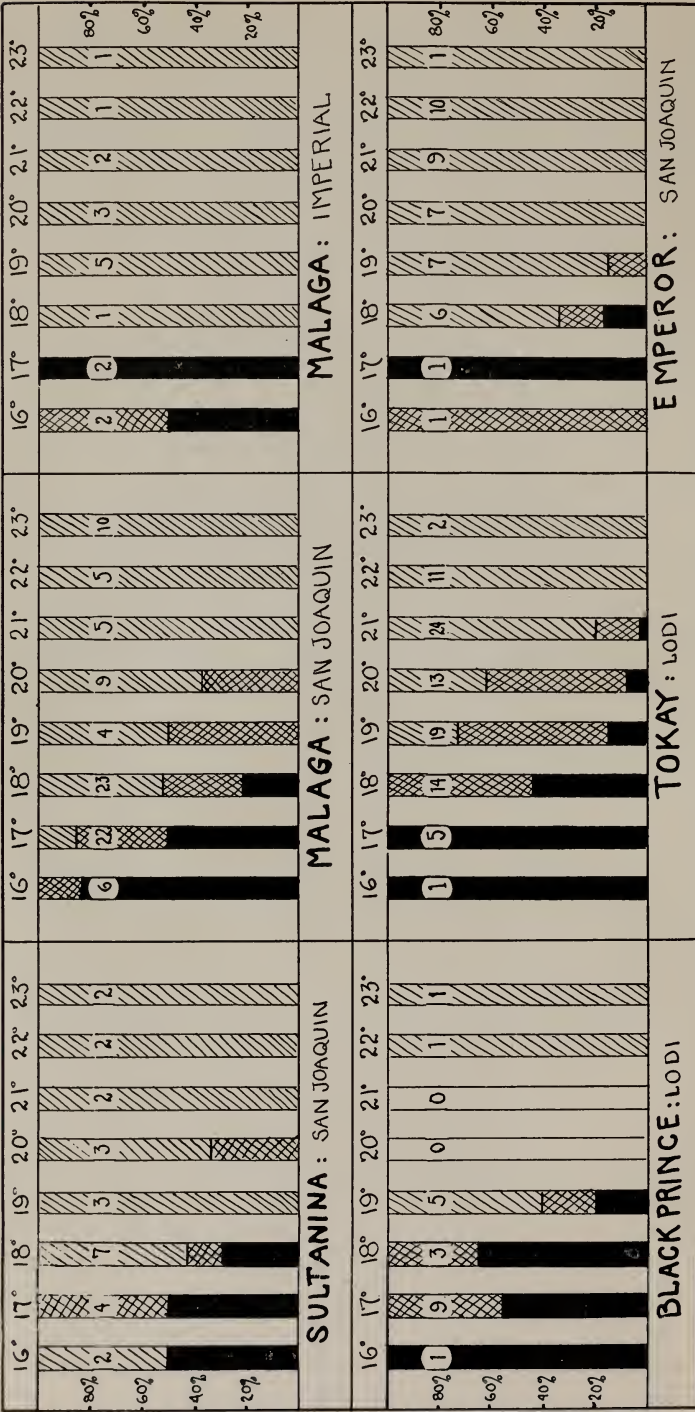


Fig.1. PERCENTAGE GOOD POOR AND BAD AT VARIOUS BALLING DEGREES

FIGURES IN COLUMNS INDICATE NUMBER OF SAMPLES UPON WHICH PERCENTAGES ARE BASED

*Influence of Variety.*—If we compare the Malaga, Tokay, and Emperor, all of which are represented by a fair number of samples, we shall find that the Balling degree at which all samples were considered good was 20° for the Emperor, 21° for the Malaga and 22° for the Tokay. It is impossible to determine whether these differences are due to the nature of the varieties either in part or in whole. It is possible, indeed probable, that the Tokay, coming in mid-season when the market is well supplied, encounters a more critical consumer. The Emperor, coming after most grapes have become rare on the market, is judged more leniently.

*Influence of Number of Samples.*—The necessity of a large number of samples to give a true measure of the consumer's taste is shown very clearly. If we consider only the three varieties, Malaga, Tokay, and Emperor, which are represented by numerous samples, change of opinion as the sugar increases is very regular. A line drawn along the tops of the percentages representing bad samples or poor samples from 16° Balling up is a very smooth curve except on the Emperor where the curve is regular only from 18° Balling up, because the lower degrees are represented by only one sample each (see fig. 1).

*Acid, and Balling:Acid Ratios.*—When we taste a grape, its apparent maturity or quality as shown by its sweetness is not due to the sugar alone but, in part, to the ratio between sugar and acid and, as already pointed out, this ratio has been proposed as a basis of standardization. Another basis that might be used is the acidity alone because as the grape ripens the acidity diminishes.

Figure 2 has been prepared from the data of the Malaga samples as a means of comparing the relative values of the three bases of standardization. The last graph—Balling degree and quality—shows the position of the individual samples from the San Joaquin Valley by black dots and that of groups of variants by small circles. The large circles show the position of the individual samples from Imperial. The other graphs show the position of the individual samples from Imperial, but the position only of the groups from the San Joaquin.

A comparison of the three standards is perhaps best made by considering one individual sample. The sample marked by A and a large circle was No. 14 from Imperial. Its composition compared with the average for the San Joaquin samples of the same Balling degree is shown below.

	No. 14 from Imperial	Mean from San Joaquin
Balling degree .....	16.40	16.40
Acid .....	.66	.99
Balling:Acid ratio .....	24.80	16.50

## MALAGA

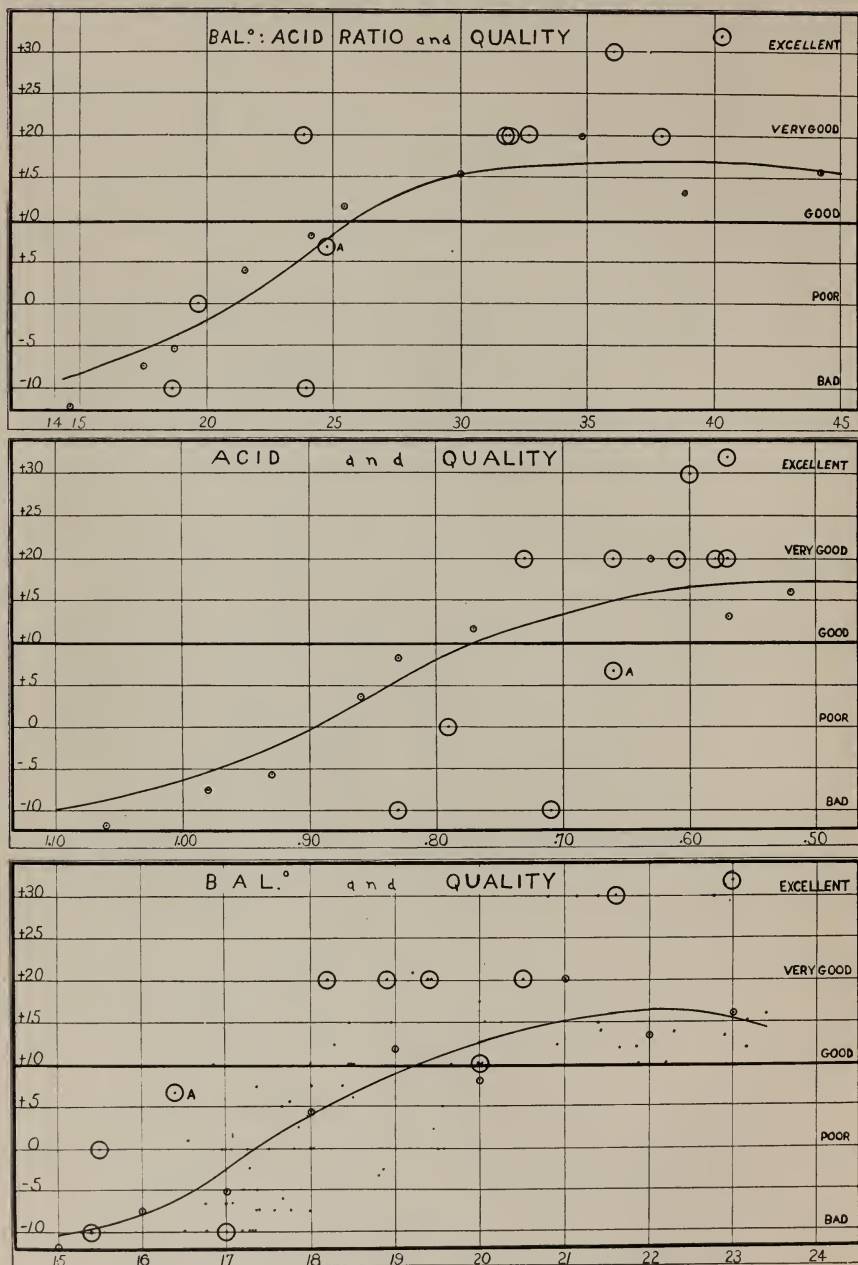


Fig. 2

There can be little doubt that this was an inferior grape although it was given a rating of  $+6.6$  by the jury and, therefore, just above the  $+5$  line which limits poor quality. A grape which has only two-thirds of the normal acidity for its Balling degree is a poorly nourished grape which will never develop into a grape of high quality however long it remains on the vine. It will always be lacking in the flavor which distinguishes a good eating grape. The different positions assigned to this grape by the three standards is interesting. By the Balling or sugar test it would be excluded by the present standard of  $17^{\circ}$  Balling. By an acid test which, for Malaga, could hardly be placed lower than .80 it would be included with the best. By the Balling:acid test it would be almost exactly on the border line of 25 which would be perhaps a reasonable position for this standard.

This indicates that the acid test is quite unreliable and that the ratio test is less suitable than the Balling test alone.

*Minimum Standard Indicated.*—Whether we consider varieties or localities or season, however, the evidence indicates that in no case is  $17^{\circ}$  Balling sufficiently high. (See figs. 2 and 3.) There is also no evidence to justify the special standard of  $16^{\circ}$  Balling for Emperor—only two, or less than 5 per cent, of the samples tested fell below  $18^{\circ}$  and these two samples were classed as bad or poor.

If we take these data at their face value, the decision must be that suitable minimum standards are for Emperor  $18^{\circ}$ , for Malaga  $19^{\circ}$ , for Sultanina  $20^{\circ}$ , and for Tokay  $21^{\circ}$  (fig. 1). That some of the samples even at these percentages were classed as poor or even bad is not an insuperable objection for reasons already pointed out, and also because of various tastes and degrees of competence of the jurors and because some of the samples classified as bad were probably in bad condition and would have been rejected on this score. All that we can expect to do is to insure that the grapes which reach the market will please a large majority of the consumers who buy them.

A better way of using these data for the determination of a suitable standard is shown in figure 3 and the bottom graph of figure 2. In these figures, the black dots show the position of each sample regarding the Balling degree and the taste of the jury. The diagonal line is a smooth curve drawn from the small circles which represent the average of the variants differing by  $1^{\circ}$  Balling. If we assume that the point where this line passes through the horizontal line, ( $+5$ ), dividing the "poor" from the "good" represents the minimum quality, we obtain for the four varieties the following standards—

SUGAR and QUALITY

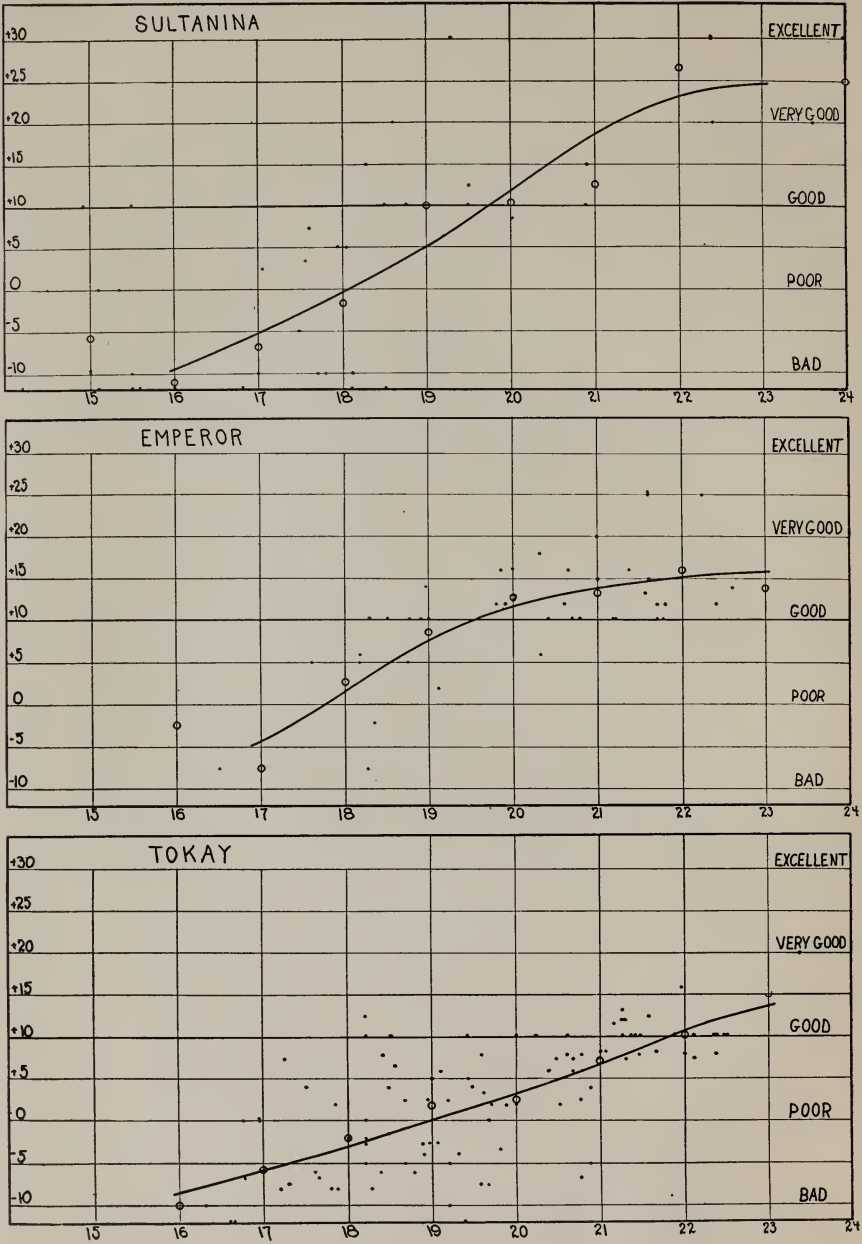


Fig. 3

Malaga 18.2°, Emperor 18.5°, Sultanina 19°, and Tokay 20.5°, which is from .5° higher to 1° lower than the estimates made from figure 1. It is more reliable because the smoothing of the curves allows for unavoidable mistakes of judgment.

The best standard is that which includes the fewest poor grapes and excludes the fewest good grapes. If we accept the + 5 horizontal line as the division between the grapes that should be excluded and those which should be included, the best standard will be represented by the vertical line which excludes the fewest samples above the + 5 line and includes the fewest below this line.

An examination of the graphs of figure 3 and the lowest graph of figure 2 makes it possible to estimate the efficiency of different standards in excluding bad grapes and including good ones. The results are shown in the following table:

TABLE 1  
INCLUSION OF BAD AND POOR SAMPLES AND EXCLUSION OF GOOD  
WITH VARIOUS BALLING DEGREE STANDARDS

	Standard	Inferior samples included,		Good samples excluded	Misplaced samples, total per cent
		bad	poor		
<i>Malaga</i> (120 samples)	17.0° B.	12	16	1	29 = 24.0
	18.0	0	8	1	9 = 7.5
	18.5	0	5	3	8 = 6.7
	19.0	0	3	9	12 = 10.0
<i>Sultanina</i> (43 samples)	17.0° B.	7	0	2	9 = 21.0
	18.0	3	0	2	5 = 11.7
	19.0	0	0	5	5 = 11.7
<i>Emperor</i> (42 samples)	16.0° B.	2	2	0	4 = 9.5
	17.0	1	2	0	3 = 7.1
	18.0	1	2	1	4 = 9.5
	19.0	0	1	8	9 = 21.4
<i>Tokay</i> (99 samples)	17.0	14	28	0	42 = 42.5
	18.0	8	27	0	35 = 35.4
	19.0	5	15	3	23 = 23.2
	20.0	1	5	4	10 = 10.1
	21.0	0	0	7	7 = 7.1

Table 1 indicates that the best segregation of the bad and the good grapes would be by a standard of 17° Balling for the Emperor, of 18° Balling for the Malaga and Sultanina and of 20° Balling for the Tokay.

We are thus led to three slightly varying results by considering the data in three different ways (*a*) by inspection of the relative number of samples at different qualities at different Balling degrees (figure 1); (*b*) by noting at what Balling degree the correlation curve crosses the line between "poor" and "good" quality (figs. 2 and 3); and (*c*) by noting what Balling degree gives the best separation of the good and bad samples (fig. 3 and bottom graph fig. 2). By taking the average of these three groups of results, we probably come as near the true state of affairs as is possible with the incomplete data on which they are based. This average is shown in the following table.

TABLE 2  
INDICATED MINIMUM STANDARD

Variety	(a)	(b)	(c)	Means
Emperor .....	18	18.5	17	17.8 say 18.0
Malaga .....	19	18.2	18	18.4 say 18.5
Sultanina .....	20	19.0	18	19.0 say 19.0
Tokay .....	21	20.5	20	20.5 say 20.5

## DISCUSSION

The value of the results of this investigation depends upon the accuracy of the tests, the competence of the juries and the extent of the field covered.

The accuracy of the tests may be considered sufficient, as it is at least equal to that which could be obtained in the application of any fruit standardization law. The extent of the field, however, is insufficient. It should cover more varieties, more localities and more samples before it can provide a reliable basis for a choice of standards.

The complete competence of the jurors, moreover, may be questioned. The graphs indicate that they attempted to be fair but that perhaps some, at least, were influenced by a subconscious bias. If we compare the classification of the Tokay samples with that of the Sultanina, Emperor, and Malaga, it seems highly probable that some factor entered into the judgments in one case that was absent in the others. Of the Tokay samples, the jurors classed as bad or poor 48 per cent of those over 17° Balling, 42 per cent of those over 18° Balling, 29 per cent of those over 19° Balling, and 12 per cent of those over 20° Balling. Yet, every sample of Sultanina over 19° Balling except one, was classed as good, or better, and only 3 per cent of Emperor and 7.5 per cent of Malaga samples showing 19° Balling or over were classed as poor. It seems that some factor other than those

of sweetness and flavor must have influenced the tasters of Tokay. That this may have been color seems to be indicated by the following table showing the average judgment of samples of light color, of fair color and of good color at each Balling degree.

TABLE 3  
BALLING, COLOR AND QUALITY IN TOKAY SAMPLES

Balling	Light color	Fair color	Good color
17	— 7.5 ( 8)*	— 1.3 (2)	.....
18	— 1.0 (13)	— 0.3 (3)	— 1.0 ( 2)
19	— 1.0 (15)	— 2.5 (1)	+ 4.6 ( 4)
20	0.0 ( 7)	+ 6.0 (1)	+ 5.5 ( 5)
21	+ 7.9 ( 6)	.....	+ 6.9 (18)
22	+ 7.5 ( 1)	.....	+ 10.3 (10)
23	.....	.....	+ 15.0 ( 2)

\* The figures in parentheses are the number of samples; the other figures, the ratings as explained on page 5.

The table indicates that the judgment of the tasters was influenced by color to some extent. There is little difference after 21° Balling is reached, or below 19° Balling, but at 19° and 20° Balling the well colored samples are rated considerably higher than the light colored.

It seems then from this preliminary inquiry that a single invariable standard has serious defects and that a perfect standardization law might have to adopt standards which varied with variety and season, and perhaps with locality or even color. The following table based on the data shown in figure 1 shows the evidence on some of these points.

INFLUENCE OF VARIETY, LOCALITY AND SEASON ON THE CORRELATION OF  
BALLING DEGREE AND QUALITY

(See fig. 1)

The figures represent percentages

	17°			18°			19°			20°			21°			22°		
	B	P	G	B	P	G	B	P	G	B	P	G	B	P	G	B	P	G
Variety																		
Malaga	51	35	14	22	30	48	0	50	50	0	34	66	....	....	100	....	....	100
Tokay	100	....	....	45	55	....	16	58	26	8	54	38	6	14	80	....	....	100
Emperor*	50	50	....	16	18	66	....	15	85	....	....	100	....	....	100	....	....	100
Localities																		
Imperial*	75	25	....	....	....	100	....	....	100	....	....	100	....	....	100	....	....	100
San Joaquin	50	43	7	19	24	57	....	33	67	0	17	83	0	0	100	....	....	100
Lodi	100	....	....	45	55	....	16	58	26	8	54	38	6	14	80	....	....	100
Season																		
Early	75	25	....	....	....	100	....	....	100	....	....	100	....	....	100	....	....	100
Midseason	75	18	7	34	42	24	8	54	38	4	44	52	3	7	90	....	....	100
Late	50	50	....	16	18	66	....	15	85	....	....	100	....	....	100	....	....	100

B = bad; P = poor; G = good or better; B + P + G = 100.

\* = 16° and 17° balling included.

We may assume that when 80 per cent of the jury consider the sample good or better that there is no doubt of its being of sufficiently high quality to please the average consumer. With this assumption it appears that the Emperor was good when it reached 19° Balling, and the Malaga and Tokay when they reached 21° Balling. The grapes from Imperial were good at 18°, those from the Upper San Joaquin at 20° Balling, and those from Lodi at 21° Balling. Early grapes were found satisfactory when they reached 18°, late grapes when they reached 19° Balling, and mid-season grapes when they reached 21° Balling.

It is probable that variety, locality and season each has its effect in modifying the taste of the consumer, but how much influence each exerts the data are too meagre to determine exactly.

The variety may influence the taste of the consumer directly by the combination of flavor, sugar and acidity, and texture, or indirectly by the psychological influence of color, size or other visual effect. The locality may influence any of the factors which determine the judgment of the consumer. The Balling:acid ratio may vary for the same variety in different localities owing to the influence of climate and soil, and the same is true of color, size and flavor. The season may change the judgment by making the taster more or less critical according to the rarity or abundance of grapes. When the earliest grapes reach the market, the consumer has not eaten grapes for many months and, when the latest arrive, grapes have become a rarity. In mid-season, there is much competition not only between different lots of grapes but with other fruits, and the taste for grapes has been more or less satiated.

## CONCLUSIONS

The only conclusions that it seems safe to draw from this study are:

1. That the Balling degree test is the simplest and most reliable that can be used practically in determining the degree of ripeness of grapes for the purposes of the standardization of shipping grapes.

2. That the standardization law of 1921 probably requires modifications of its provisions regarding the Balling degrees required for shipping grapes.

3. That these modifications should probably include adjustments of the required Balling degree to suit the varying conditions of variety and season. The need of an adjustment for variations of locality is doubtful, and, in any case, would be very difficult of enforcement.

4. That more information is needed before the proper modifications of the law can be made.

5. That the method used in this investigation if sufficiently expanded and improved in detail in the light of the experiences obtained is a good, perhaps the best, method of quickly reaching a wise decision in this matter.

